Saskatchewan

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Agriculture Development Fund

FINAL REPORT

LOW DISTURBANCE INJECTION OF SWINE MANURE INTO ALFALFA PRODUCED FOR DEHY

19970304

Funded by
The Agriculture Development Fund

September 2001
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SASKATCHEWAN AGRICULTURE & FOOD
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1. Summary

The object of this project was to research the effects and demonstrate a method of swine manure injection into alfalfa fields and zero till cropland.

Injection of the alfalfa sites was done with the Greentrac injection system in Year 1 and Year 2. In Year 3, application was changed from spring to fall, and the plots were injected with modified Bourgault mid-row banders (coulters). Both injection systems used coulters to open a slot in the alfalfa ¾ in. wide by 3 ½ in. deep.

Alfalfa root damage caused by injection in the disturbed check resulted in lower forage yield compared to the undisturbed check at both sites. At the Star City site, there was an increase in forage yields at all three application rates, ranging from 120 to 145 percent of the check. Protein levels also increased with higher manure application rates. In contrast, at the Valparasio site, none of the manure application treatments resulted in a forage yield increase. The reason for the yield response differences between the two sites was likely due to an S and possible a P deficiency at the Star City site.

The yield and quality of alfalfa will improve with the addition of swine manure if the fields are deficient in S, P, and K; however, if the soil nutrients are generally adequate for alfalfa production, the damage to the alfalfa plants from injection may result in yield losses.

At the Brooksby zero till site, the Greentrac machine plugged and did not perform well and as such has been determined to be unsuitable for zero till injection work and in fact the machine was not designed for this purpose. In fall 1998 and 1999, application was applied successfully using the PAMI low disturbance swine manure injection system. Annual application of hog manure resulted in similar yield response to commercial fertilizer at equivalent application rates. However, when the manure application rate was doubled, the grain yield did not increase in comparison to the equivalent commercial fertilizer application. In this study, the manure N was used in the year of application with no yield response in the following year, even at higher manure application rates. While manure application increased yield and overall N yield, its early uptake may not make it suitable as a means of increasing N in seed yield as seen in the canola application.

A PAMI Research Update #751, "Is Swine Manure Injection into Alfalfa Stands a Good Idea?" has been published to provide more detailed information to those who are interested.

2. Introduction

The expansion of the hog industry has created a demand for suitable locations for barns where there is land available for manure injection. The increasing trend to zero or minimum tillage makes less land available for injection. As well, perennial crops such as alfalfa are not used for injection, as it is not known if it would be of benefit to alfalfa, and if it could be done without damaging the crop. In addition, if alfalfa crops were suitable for injection it would offer the benefit of a wider window of application timing to hog producers.

This research and demonstration is to determine the effect of low disturbance swine manure injection into alfalfa and into a zero till crop rotation with the Greentrac manure injection machine. The Greentrac is a manure injection machine built in Ireland and widely used in Europe for grassland injection. In other projects the Greentrac is being used very successfully to inject swine manure into pasture and forage land.

3. Project Description

3.1 Dehy Alfalfa Sites

The Greentrac manure injection machine was used to inject two test sites in alfalfa dehy production in the Tisdale area. Both sites were seeded to alfalfa in the fall of 1997 on canola stubble and were at the seedling stage of alfalfa when injected in spring 1998. The second manure application was applied to the sites in spring 1999. The Year 3 treatments were applied in fall 1999 using the PAMI low disturbance manure injector. The sites are located at the Don Squires farm (SW 14-45-16 W2) north west of Valparasio, and at the Clarence Mitchell farm (NE 35-44-16 W2) south west of Star City.

A RCBD (Radomized Complete Plot Design) with four replicates was used at each site with plot dimensions of 10 x 100 ft. Swine manure was injected at rates of 3333, 6666, and 13,322 Imperial gallons/acre (gpa) to provide approximately 50, 100, and 200 lb/ac of available N. Total N injected would be twice these rates with the assumption that half the N is plant available in the first year. Injection dates were May 4, 1998, in Year 1; May 25, 1999, in Year 2; and October 4, 1999, in Year 3. Treatments listed are for Year 1, with Year 2 and Year 3 in brackets.

Treatments

1. Check - not worked
2. Check - Greentrac injector pass with **no** manure application
3. 1X (1X, 1X)
4. 2X (0X, 2X)
5. 4X (0X, 0X)

Injection depth with the coulter system averaged about 3½ inches. Sampling of the manure was carried out at injection to allow a precise determination of rate after analysis. Two check strips were included in the experiment, including an unworked check strip and a worked check strip. The worked check strip refers to the treatment where the Greentrac injector system or PAMI low disturbance manure injector was operated with the coulters at standard operating depth but with no swine manure application.

Soil samples, before and after injection, were taken at the 0 to 48 in. depth and analyzed for N, P, K, and S. See **Appendix II** for results.

Harvest samples of the alfalfa sites were taken on two separate cutting dates with a small plot forage harvester and analyzed by Kapt-Al Services Ltd. At the Valparasio site, the second cut was not taken in the summer of 1999, as the commercial harvesters were at the site before the research samples could be taken. The first cut was not taken at the Valparasio site in the summer of 2000, as the commercial harvesters cut the plots the day before sampling was scheduled.

3.2 Zero Till Site

Another site, in a zero till crop rotation, was located at the Garry Meier farm (SE 16-47-16 W2) north east of Brooksby. This land was previously in pea production and was seeded to flax in spring 1998, and canola in spring 2000. The zero till part of the project was conducted in co-operation with Dr. Adrian Johnston and Dr. S. S. Malhi of the Melfort Research Station.

Treatments at this site were similar to the dehy alfalfa sites plus the addition of three urea fertilizer treatments (50,100, and 200 lb/ac N). Treatments listed are for Year 1 with Year 2 and Year 3 in brackets.

Treatments

1. Check - not worked
2. Check - Greentrac injector pass with **no** manure application
3. 1X (1X, 1X)
4. 2X (0X, 2X)
5. 4X (0X, 0X)
6. 1X lb/ac fertilizer N (1X, 1X)
7. 2X lb/ac fertilizer N (2X, 2X)
8. 4X lb/ac fertilizer N (4X, 4X)

The manure and fertilizer treatments were applied on May 4, 1998, using the Greentrac injector for the swine manure and the Agriculture and Agri-Food Canada's Conserva Pak plot drill to apply the urea N treatments. In spring, this site was zero till seeded with Laser Canadian Extra Strong wheat. On October 28, 1998, and October 14, 1999, the treatments were applied using the PAMI low disturbance manure injector and Agri-Food Canada's Conserva Pak plot drill to apply the urea N treatments.

A tour of the Star City site was conducted July 15, 1998, and July 25, 1999, in conjunction with research tours in the area organized by Westco Fertilizer and Agriculture Canada. Plot signage and verbal recognition of ADF sponsorships were provided and a large group of farmers attended.

4. Results and Discussion

4.1 Dehy Alfalfa Sites

In spring 1998 and spring 1999, swine manure injection was delayed at both sites due to wet field conditions. Field observations indicated that the coulter system cut a clean slot about ¾ in. wide by 3½ in. deep with almost no soil disturbance outside of the slot. Depth of penetration was the maximum that the coulter would cut the soil. Injection performance at 3,333 gpa (1x) was rated fair with 100% liquid visible in the furrow and no flow outside of the furrow. Injection efficiency at 6,666 gpa (2x) and 13,322 gpa (4x) both rated poor with 10 to 20% soil surface covered with slurry at 6,666 gpa and 50% at 13,322 gpa. In fall 1999 the manure and disturbed check treatments were applied at a coulter depth averaging 2½ in. at both sites. Depth of penetration was limited by coulter penetration in the dry soil. Injection efficiency at 3,333 gpa (1x) was rated fair with 100% liquid visible and about 1% surface coverage outside of the furrow. Injection efficiency at 6,666 gpa (2x) was poor with about 10% surface coverage outside of the furrow. The reason for poor injection efficiency at the higher application rates was due to the small volume created by the ¾ x 2½ in. slots. The injection efficiency would have been somewhat improved by deeper coulter penetration (maximum operating depth 4¾ in.) but the system was unable to penetrate deeper due to inadequate spring pressure on the coulter gangs. In 1999, only the 1x and disturbed check treatments were applied. Forage yield response from the 2x and 4x treatments in 1999 depended on carry over of manure nutrients from the previous year.

The manure treatments for 2000 were applied in the fall of 1999 using the PAMI low disturbance injection system. The reason for the change in application timing was to determine if the alfalfa damage caused by the injection coulters would be reduced if the application was done in fall when the alfalfa was dormant.

In 1998, forage yields increased from the low disturbance application of swine manure at the Star City site and decreased the yields at the Valparasio site.

In 1999, forage yields increased dramatically from the addition of swine manure at the Star City site, due to the application of swine manure the previous year. In contrast, forage yield had very little response to swine manure at the Valparasio site.

In 2000, forage yield increased from the addition of swine manure at the Star City site and yield decreased at the Valparasio site.

When the forage yield data from 1998, 1999, and 2000 were averaged, the injection of swine manure resulted in yield increases at the Star City site and yield decreases at the Valparasio site.

The disturbed check yielded 10% lower forage yields at the Star City site and 23% lower forage yields at the Valparasio site compared to the undisturbed check at both sites.

The 1998, 1999, and 2000 results at the alfalfa dehy sites are summarized in the following sections.

4.1.1 Star City Site 1998

The first cut results demonstrated a severe setback in dry matter yield due to the injection process. All manure treatments yielded less than the undisturbed check and the effect of disturbance was so severe that the disturbed check yielded 40% less than the undisturbed check.

At the second cut the alfalfa recovered from the mechanical damage and all manure treatments exceeded the check by at least 38%. Similarly, at the second cut the disturbed check yielded only 7% less than the undisturbed check.

When the dry matter yields from cut one and two were combined, all of the manure treatments out yielded the check. In contrast, the disturbed check yielded 19% less than the undisturbed check.

In 1998, the injection of swine manure reduced the dry matter yield of the first cut, but the alfalfa recovered and all manure treatments out yielded the check when the dry matter yield of both cuts was combined.

4.1.2 Star City Site 1999

Unlike Year 1, both the first cut and second cut had large increases in forage yield due to the application of swine manure. Although the yield reduction was smaller than the previous year, the disturbed checks yielded 14% less than the undisturbed check.

When the dry matter yields of the two cuts were averaged, all manure treatments out yielded the undisturbed check ranging from a 15% yield increase for the 1x treatment to a 51% increase for the 4x treatment.

In summary, the injection of swine manure resulted in large forage yield responses at this site in spite of damage caused by the low disturbance injection.

4.1.3 Star City Site 2000

Similar to the previous years, there were large increases in forage yield due to the application of swine manure with a minimum 32% increase in forage yield compared to the undisturbed check.

Unlike the previous years, there was no yield decrease for the disturbed check compared to the undisturbed check. The fall application may have reduced injection damage compared to spring application. However, the reduced damage from fall application did not occur at the Valparasio site.

In summary, the injection of swine manure at the Star City site resulted in large forage yield responses, similar to the previous two years'.

4.1.4 Valparasio Site 1998

Similar to the Star City site, the first cut demonstrated a severe cutback in dry matter yield due to the injection process with lower yields for all manure treatments compared to the undisturbed check. The effect of the injection injury was so severe that the disturbed check yielded 44% less than the undisturbed check.

In contrast to the Star City site, the alfalfa did not respond to manure application at the second cut and dry matter yields were similar to the undisturbed check. Dry matter yield of the disturbed and undisturbed checks were similar indicating the alfalfa had recovered from the injection injury at the time of the second cut.

When the dry matter yield from cut one and two were combined all treatments yielded the same or less than the undisturbed check with yield reductions of up to 33%. The total yield of the disturbed check was 22% less than the undisturbed check. In summary, the injection of swine manure at the Valparasio site resulted in a reduction of, or at best equal, dry matter yields when compared to the undisturbed check.

4.1.5 Valparasio Site 1999

At the Valparasio site, the second cut was not taken as the commercial forage harvesters cut the site before the plot samples were taken.

Forage yield response to swine manure from the first cut was very poor at this site in 1999 with the 2x and 4x treatments yielding only 7 and 9%, respectively, above the check. Those treatments were both applied the previous spring so it is unlikely that injection coulter damage was the cause of the poor crop response. In contrast, the 1x treatment applied in spring yielded 44% less than the undisturbed check. In addition the

disturbed check forage yield was 35% lower than undisturbed check. These results indicate that alfalfa damage from mechanical injection causes severe yield reductions at this site and even when high quantities of manure are applied the benefit from the nutrients does not compensate for crop damage.

4.1.6 Valparasio Site 2000

Forage yield response to swine manure was negative at this site in 2000, with all swine manure treatments yielding at least 15% lower than the undisturbed check. At this site, the alfalfa damage from mechanical injection caused severe yield reductions and the benefits from the manure nutrients does not compensate for crop damage.

4.2 Zero Till Site

The Greentrac machine did not work properly in the zero till field due to plugging the toolbar as result of pea residue buildup in front of the coulters. Field modifications were made to the machine to allow the injection to be completed in the spring of 1998. To prevent plugging, the coulters were set to penetrate only 2 in. into the soil. This was effective in preventing plugging but resulted in about 10% of the slurry on the soil surface at the 3,333 gpa application rate and much higher levels of surface application at 6,666 gpa and 13,332 gpa application rates. Work on other projects confirmed that the Greentrac coulter injector plugged in stubble conditions and is not suitable for zero till swine manure injection. It should be noted that the Greentrac coulter injector was not designed for operation in zero till conditions and so its lack of performance in zero till should not be considered a criticism of the product.

Agriculture and Agri-Food Canada from Melfort conducted field maintenance, soil sampling, and harvesting of the plots.

In the fall of 1998 and 1999, a coulter-type injector developed by PAMI, as part of an ADF project, was used to apply the manure to the zero till site. The 1x rate of 3,333 gpa was applied October 28, 1998, at a depth of 5 in. Injection performance was rated excellent with no slurry visible in the furrows except in the wheel tracks. On October 14, 1999, the manure was injected at an average depth of 5 ½ in. at rates of 1x (3,333 gpa) and 2x (6,666 gpa) in addition to the disturbed check. Injection efficiency was excellent at the 1x rate with no visible slurry in the furrows. In contrast, injection efficiency at the 2x rate was poor with about 5% surface coverage outside the furrow.

4.2.1 1998 – Flax

There was little impact of hog manure application on the variables measured in Year 1 when flax was the crop grown. The lack of response was likely due to the carryover of N from the previous pea crop. While not significant, the manure treatments had lower seedling emergence than the check and fertilized treatments, likely a reflection of the soil disturbance from manure application with this fine seeded crop. The 80 to 120 lb.N/ac fertilizer rates did increase grain N yield and total N yield over the other treatments in 1998. The absence of an increase in the N harvest index (grain N yield/total N yield) for these treatments indicates that a proportional amount of N was accumulated in both the grain and straw of these crops at the high fertilizer N rates.

4.2.2 1999 – Hard Red Spring Wheat

Hog manure treatments resulted in lower wheat seedling emergence in 1999, similar to the flax in 1998. The high fertilizer N treatments (80 and 120 lb.N/ac) increased grain and total dry matter yield over that of the manure treatments. However, there was no difference between the Manure 50 lb.N/ac and Fertilizer 40 lb.N/ac treatments, indicating that the two nutrient forms were acting similarly. It should be noted that for the 1999 crop year, no manure was applied with the Manure 100 lb.N/ac treatment, as it was to be applied every other year. The results for grain and total yield with the Manure 100 lb.N/ac treatment indicate that it had no residual value relative to the unfertilized check in 1999. Increased grain N content resulted from the Fertilizer 80 lb.N/ac and 120 lb.N/ac treatments providing an increased grain N yield and total N yield relative to the other treatments. However, the absence of any significant response for the N harvest index indicates that the N in the plants was balanced between the seed and total crop biomass.

4.2.3 2000 – Canola

In 2000, growing conditions were excellent, resulting in a 50 bu/ac canola crop from the trial. The absence of a grain yield response, while a large difference in total yield was recorded, illustrates the inefficient ability of canola to transform total biomass yield into grain yield. The Fertilizer 80 lb.N/ac treatment produced 25% more total biomass than the Manure 50 lb.N/ac treatment; however, they had the same grain yield. All fertilized treatments produced higher seed N yield than the unfertilized check. A similar response was recorded for the total N yield, with the exception of elevated N in the Fertilizer 200 lb.N/ac treatment, reflecting residual N in the additional straw produced with this treatment in the canola crop.

In summary, application of hog manure annually at a rate equivalent to 50 lb.N/ac provided a crop response that was similar to the Fertilizer 40 lb.N/ac treatment. However, application of double the manure rate in 1998 did not increase yield at all,

unlike that observed when the fertilizer N rate was doubled. No residual N benefit was obtained from the application of the Manure 100 lb.N/ac treatment every other year in this study – as shown by the low yield of wheat for this treatment in 1999. It would appear that at the manure N rates considered in this study, all of the N from manure was being used in the year of application. With the exception of the Fertilizer 200 lb.N/ac treatment on canola, the N in crops was distributed between grain and straw components in an equal fashion. This supports the conclusion that hog manure N was taken up early in the growing season.

Detailed results are included in **Appendix I**.

5. Conclusions

Alfalfa root damage caused by coulter injection in the disturbed check resulted in lower forage yields compared to the undisturbed check at both sites. At Star City, there was an increase in forage yields at all three application rates, ranging from 120 to 145% of the check. Protein levels also increased with higher manure application rates. In contrast, at the Valparasio site, none of the manure application treatments resulted in a forage yield increase. The reason for the yield response differences between the two sites was likely due to an S and possibly a P deficiency at the Star City site. The yield and quality of alfalfa will improve with the addition of swine manure if the fields are deficient in S, P, or K; however, if soil nutrients are adequate for alfalfa production, the damage to alfalfa plants from injection may result in yield losses.

At the Brooksby zero till site, the Greentrac machine plugged and did not perform well. When the PAMI low disturbance injection system was used in place of the Greentrac, no further application problems were encountered. Annual application of swine manure resulted in similar yield response to commercial fertilizer at equivalent application rates. However, when the manure application rate was doubled, the grain yield did not increase in comparison to the equivalent commercial fertilizer application. In this study, the manure N was used in the year of application with no yield response in the following year, even at higher manure application rates.

A research update was published to detail these results and a copy is included in **Appendix III**.

9. Project Photos

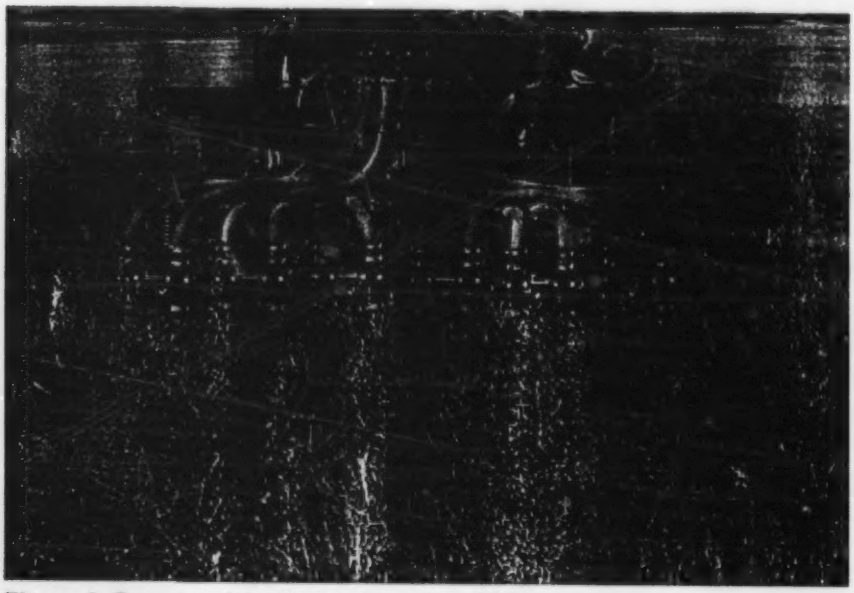


Figure 1. Greentrac Injecting into First Year Alfalfa.

Figure 2. Injection Slot in First Year Alfalfa.

Figure 3. Coulter Plugging in Stubble.

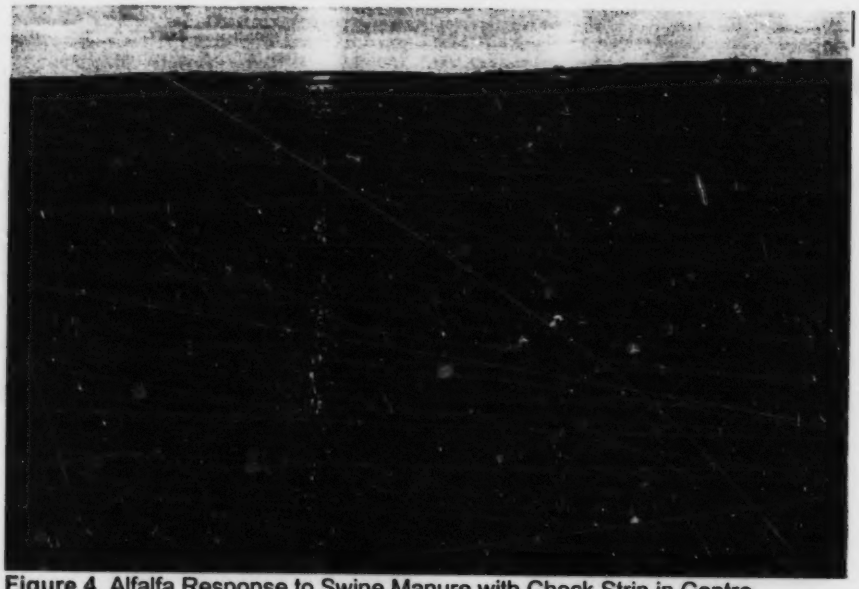


Figure 4. Alfalfa Response to Swine Manure with Check Strip in Centre.

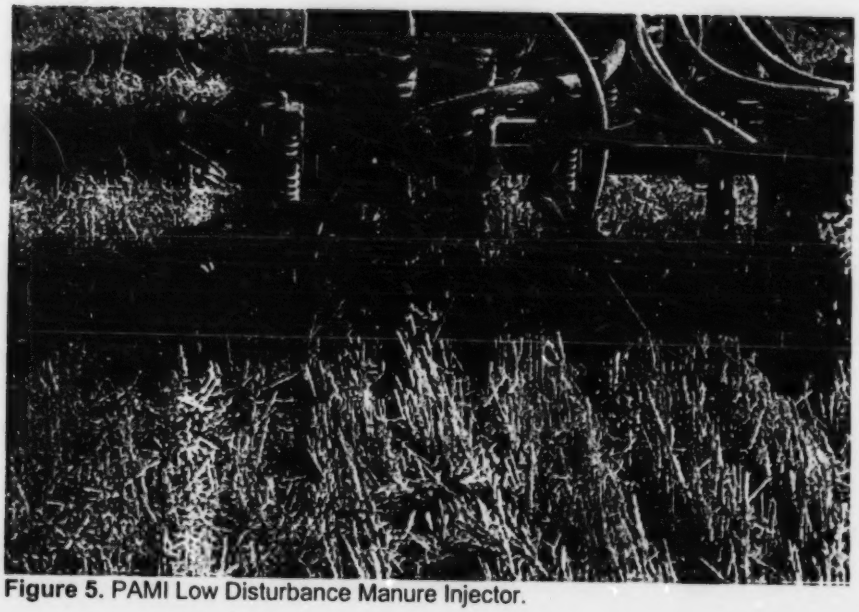


Figure 5. PAMI Low Disturbance Manure Injector.

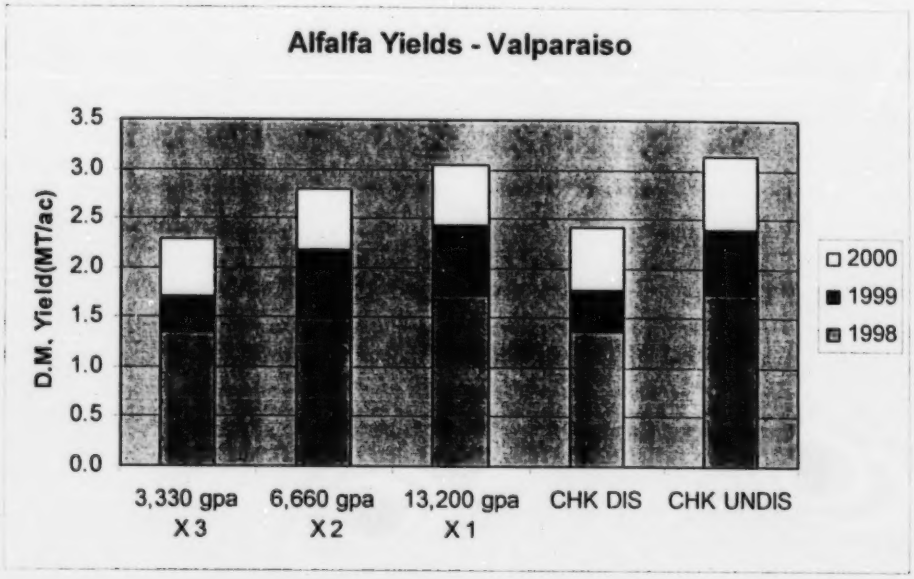
10. Acknowledgements

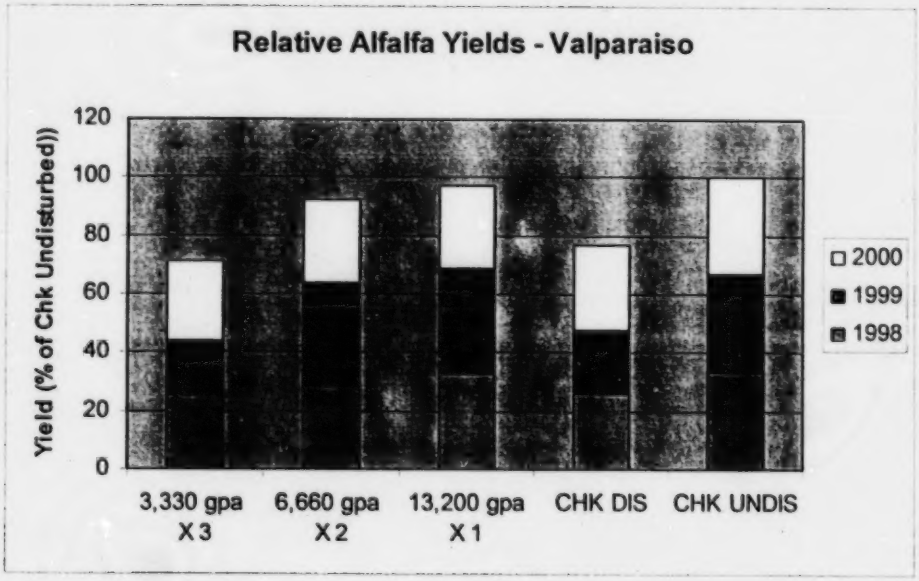
This work is being carried out with funding provided by the Agriculture Development Fund. At a site tour on July 15, 1998 and July 25, 1999, this funding was acknowledged.

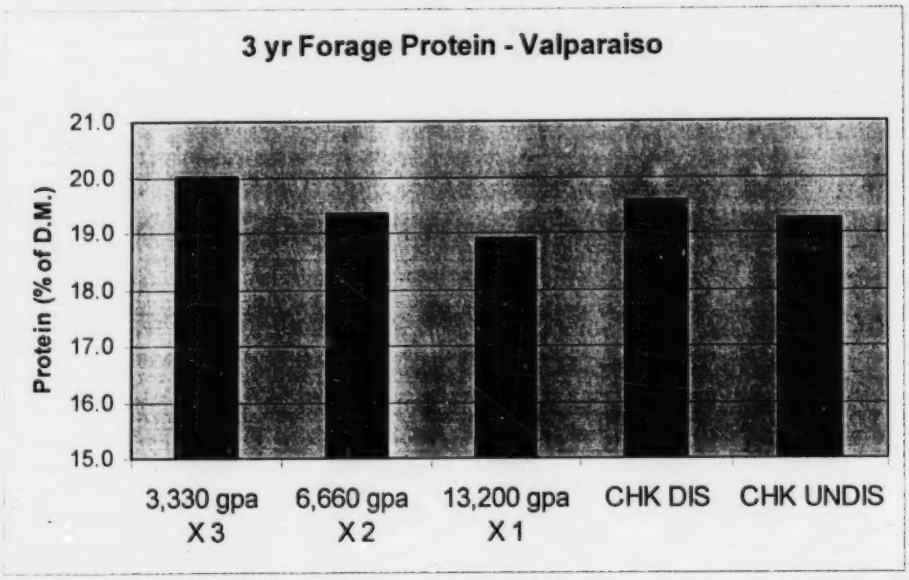
A research update was published and a press release was issued to announce it. Both publications further acknowledged the support of ADF. See copies of these publications in **Appendix III**.

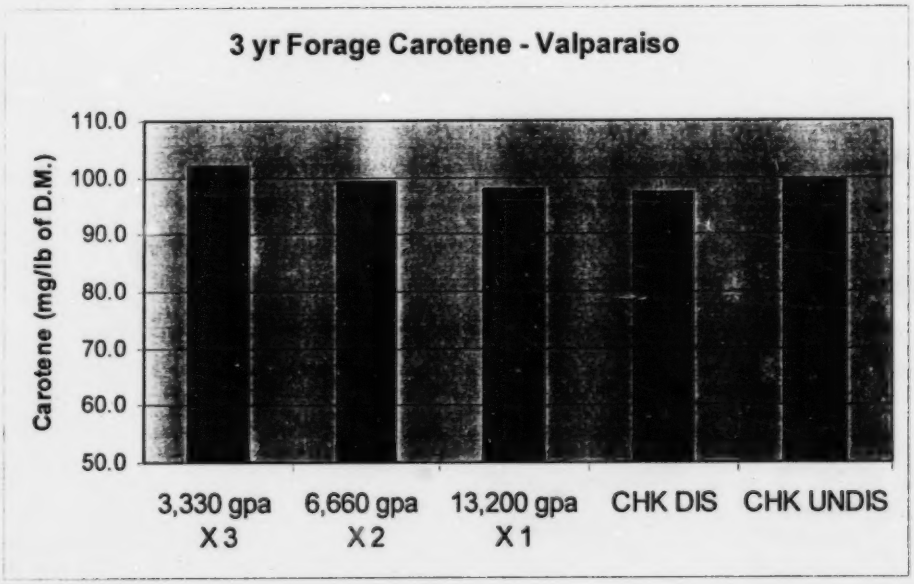
Appendix I

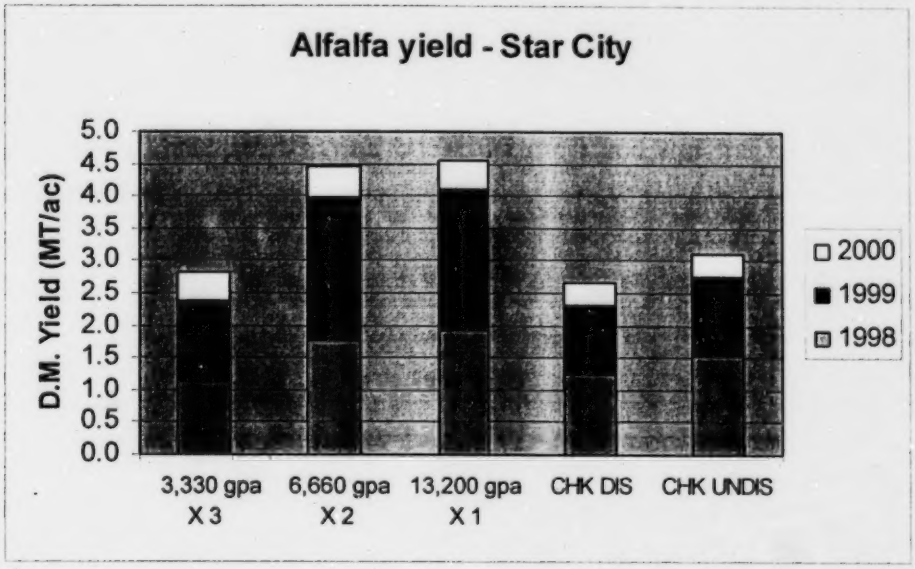
Agronomic Response to Swine Manure on Dehy Alfalfa

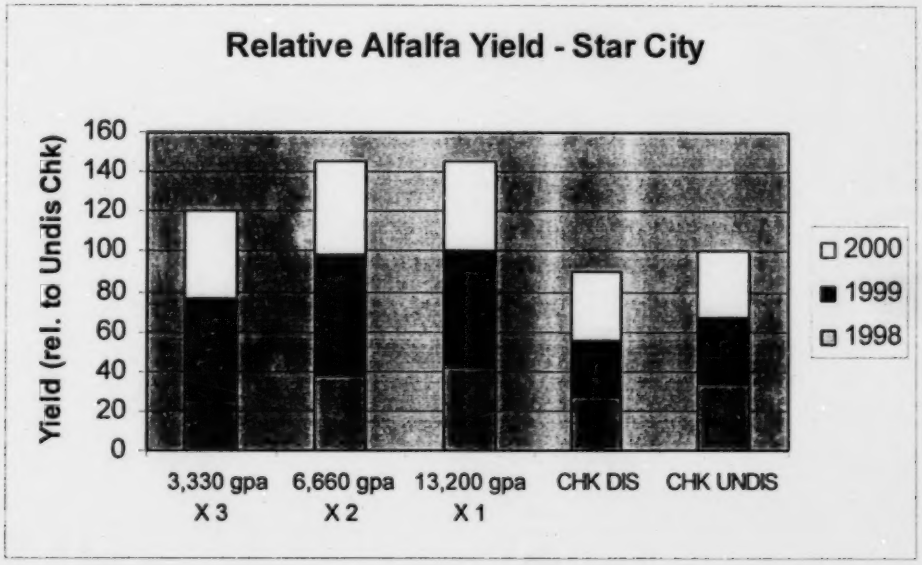


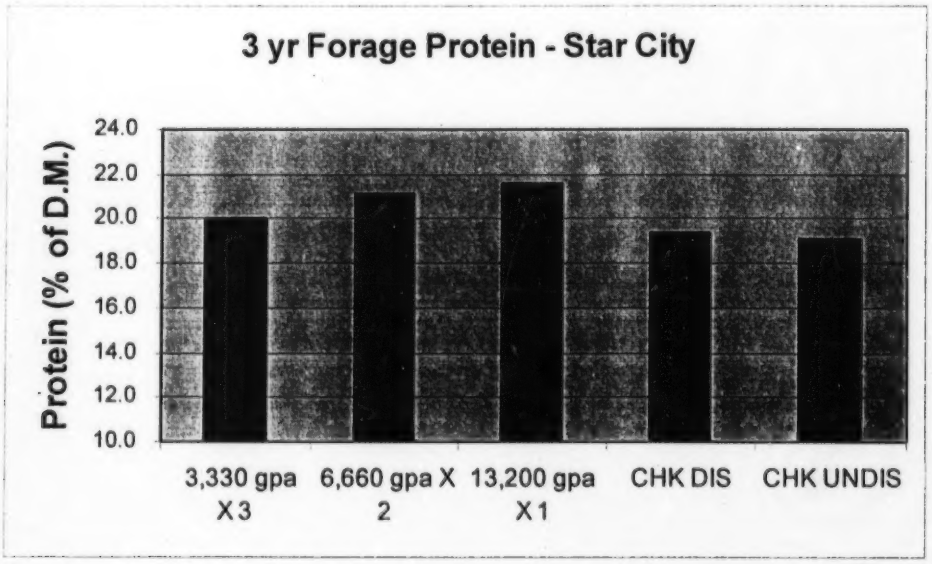


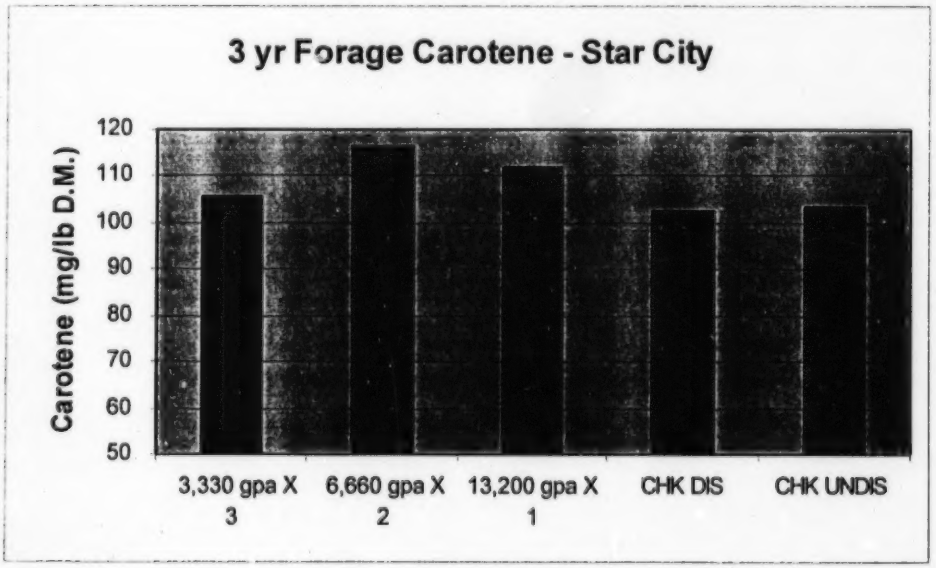

3 yr Forage Protein - Valparaiso
Protein (% of D.M.)
21.0
20.0
19.0
18.0
17.0
16.0
15.0
3,330 gpa X 3
6,660 gpa X 2
13,200 gpa X 1
CHK DIS
CHK UNDIS


3 yr Forage Carotene - Valparaiso
Carotene (mg/lb of D.M.)
110.0
100.0
90.0
80.0
70.0
60.0
50.0
3,330 gpa X 3
6,660 gpa X 2
13,200 gpa X 1
CHK DIS
CHK UNDIS


Alfalfa yield - Star City
D.M. Yield (MT/ac)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
3,330 gpa X 3
6,660 gpa X 2
13,200 gpa X 1
CHK DIS
CHK UNDIS
2000
1999
1998


Relative Alfalfa Yield - Star City
Yield (rel. to Undis Chk)
160
140
120
100
80
60
40
20
0
3,330 gpa X 3
6,660 gpa X 2
13,200 gpa X 1
CHK DIS
CHK UNDIS
2000
1999
1998


3 yr Forage Protein - Star City
Protein (% of D.M.)
24.0
22.0
20.0
18.0
16.0
14.0
12.0
10.0
3,330 gpa X 3
6,660 gpa X 2
13,200 gpa X 1
CHK DIS
CHK UNDIS


3 yr Forage Carotene - Star City
Carotene (mg/lb D.M.)
120
110
100
90
80
70
60
50
3,330 gpa X 3
6,660 gpa X 2
13,200 gpa X 1
CHK DIS
CHK UNDIS

HOG MANURE TREATMENT TEST

CLARENCE MITCHELL (Star City)
2000

		D.M. Yield (kg/ac)				Yield (% of chk undis)				Protein (% of D.M.)			Carotene (mg/lb)		
		Cut 1	Cut 2	Cut 3	Total	Cut 1	Cut 2	Cut 3	Total	Cut 1	Cut 2	Ntd Ave	Cut 1	Cut 2	Ntd Ave
1.	50 LB N	440			440	132			132	19.9		19.9	88		88
2.	100 LB N	477			477	143			143	20.7		20.7	91		91
3.	200 LB N	443			443	132			133	21.2		21.2	91		91
4.	CHK DIS	346			346	103			104	21.0		21.0	85		85
5.	CHK UNDIS	333			333	100			100	21.1		21.1	96		96
	Mean	408			408	122			93	20.775		20.8	90.05		90
	F value	1.1268			1.1268	1.1268			1.1268	2.8444		2.84	0.7769		0.78
	LSD (0.05)	186			186	45			45	0.95		0.95	14		14
	C.V. (%)	29.6			29.6	29.6			29.6	13.58		13.58	10.2		10.2

FAX NO. : 306-975-5101 Dec. 05 2000 11:50AM P2

HOG MANURE TREATMENT TEST

CLARENCE MITCHELL (Star City)

		D.M. Yield (MT/ac)				Yield (% of chk undis)				Protein (% of D.M.)				Carotene (mg/lb)			
		1998	1999	2000	Total	1998	1999	1994	Total	1998	1999	2000	Mtd Ave	1998	1999	2000	Mtd Ave
1.	50 LB N	1.13	1.24	0.44	2.81	74	155	132	120	18.2	21.7	19.9	20.0	92	125	88	106
2.	100 LB N	1.76	2.22	0.48	4.46	114	180	143	146	18.7	23.2	20.7	21.2	101	134	91	116
3.	200 LB N	1.92	2.18	0.44	4.54	125	178	133	145	19.9	23.1	21.2	21.6	99	128	91	112
4.	CHK DIS	1.25	1.06	0.35	2.66	81	86	104	90	17.4	21.3	21.0	19.4	89	125	85	103
5.	CHK UNDIS	1.54	1.23	0.33	3.10	100	100	100	100	16.8	21.5	21.1	19.1	86	127	96	104
	Mean	1.52	1.59	0.41	3.51	99	140	122	120	18.2	22.2	20.8	20.3	93	128	90	108

FAX NO. : DEC-01-2000 11:50AM P3

HOG MANURE TREATMENT TEST

DON SQUIRES (Valparaiso)
2000

	D.M. Yield (kg/ac)				Yield (% of chk undls)				Protein (% of D.M.)			Carotene (mg/lb)		
	Cut 1	Cut 2	Cut 3	Total	Cut 1	Cut 2	Cut 3	Total	Cut 1	Cut 2	Wtd Ave	Cut 1	Cut 2	Wtd Ave
1. 50 LB N		590		590		81		81		22.0	22.0		107	107
2. 100 LB N		623		623		85		85		21.3	21.3		103	103
3. 200 LB N		623		623		85		85		21.7	21.7		103	103
4. CHK DIS		640		640		88		88		20.9	20.9		98	98
5. CHK UNDIS		729		729		100		100		20.7	20.7		97	97
Mean		641		641		87		109		21.32	21.3		102	101.6
F value		1.336				1.336				1.1594			0.85	
LSD (0.05)		195				30				1.00			14	
C.V. (%)		19.8				19.8				4.5			8.8	

HOG MANURE TREATMENT TEST

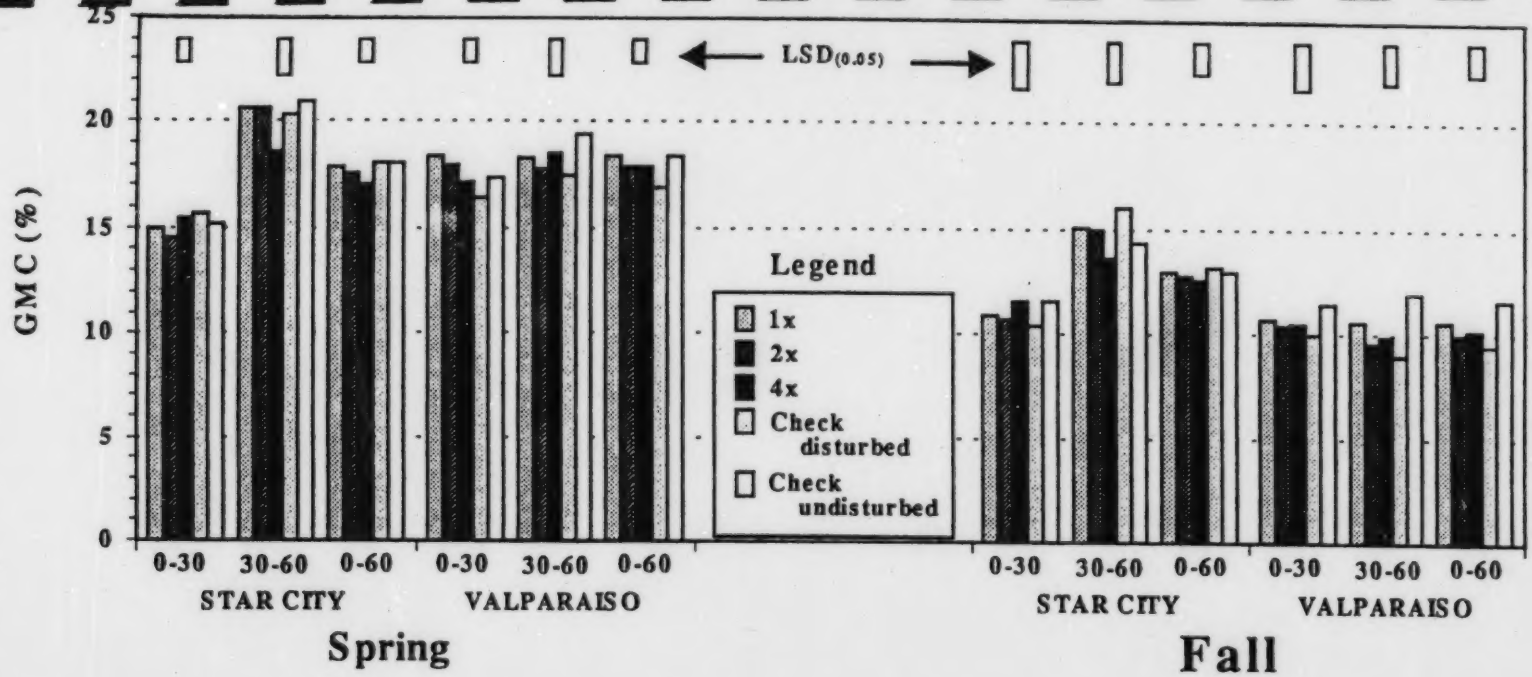
DON SQUIRES (Valparaiso)

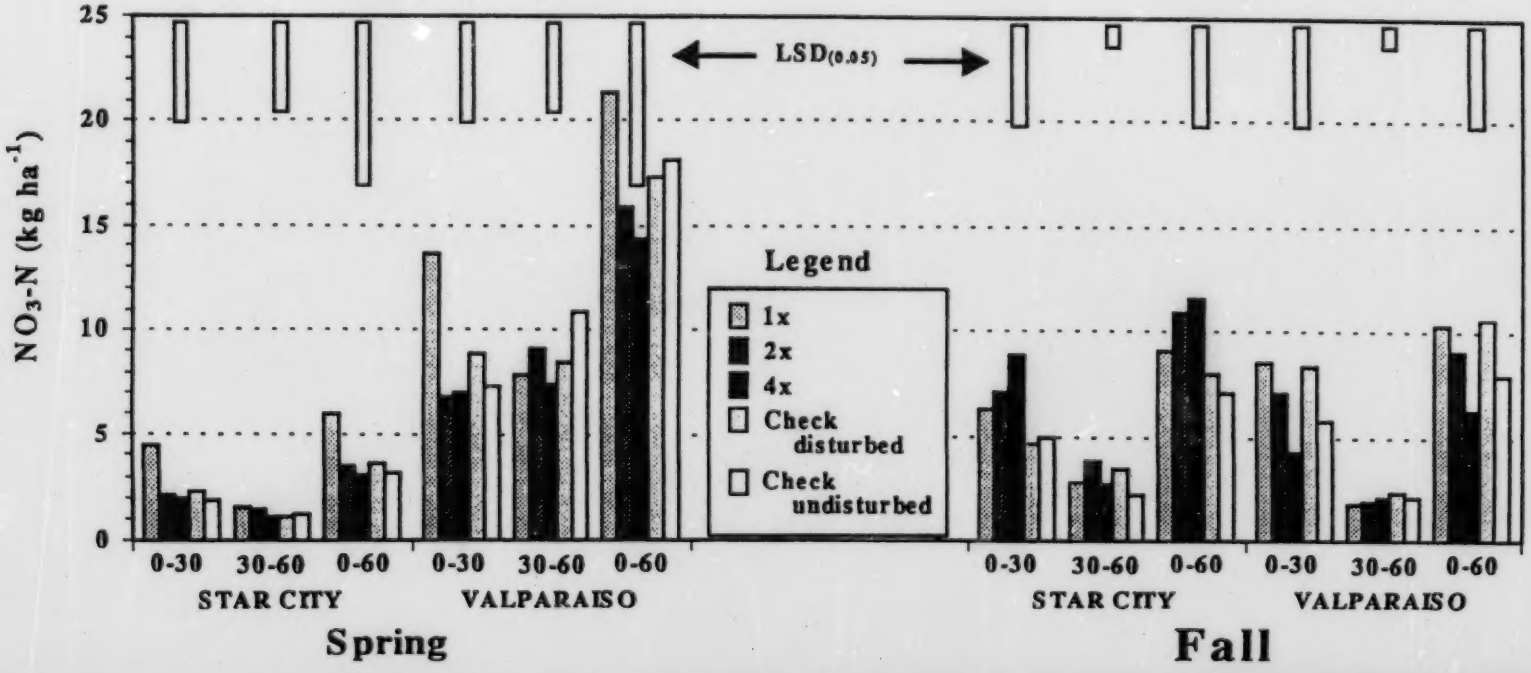
	D.M. Yield (MT/ac)				Yield (% of chk undis)				Protein (% of D.M.)				Carotene (mg/lb)			
	1998	1999	2000	Total	1998	1999	2000	Total	1998	1999	2000	Wtd. Ave.	1998	1999	2000	Wtd. Ave.
1. 50 LB N	1.34	0.36	0.59	2.29	77	55	81	73	18.9	20.9	22.0	20.0	97	112	107	102
2. 100 LB N	1.48	0.69	0.62	2.79	85	106	85	89	18.3	19.9	21.3	19.4	91	113	103	99
3. 200 LB N	1.73	0.70	0.62	3.05	99	108	85	98	17.4	20.2	21.7	18.9	91	111	103	98
4. CHK DIS	1.36	0.42	0.64	2.42	78	65	88	77	19.0	19.4	20.9	19.6	94	108	98	97
5. CHK UNDIS	1.75	0.65	0.73	3.13	100	100	100	100	18.5	19.7	20.7	19.3	95	115	97	100
Mean	1.53	0.56	0.64	2.74	88	87	88	87	18.4	20.0	21.3	19.4	94	112	102	99

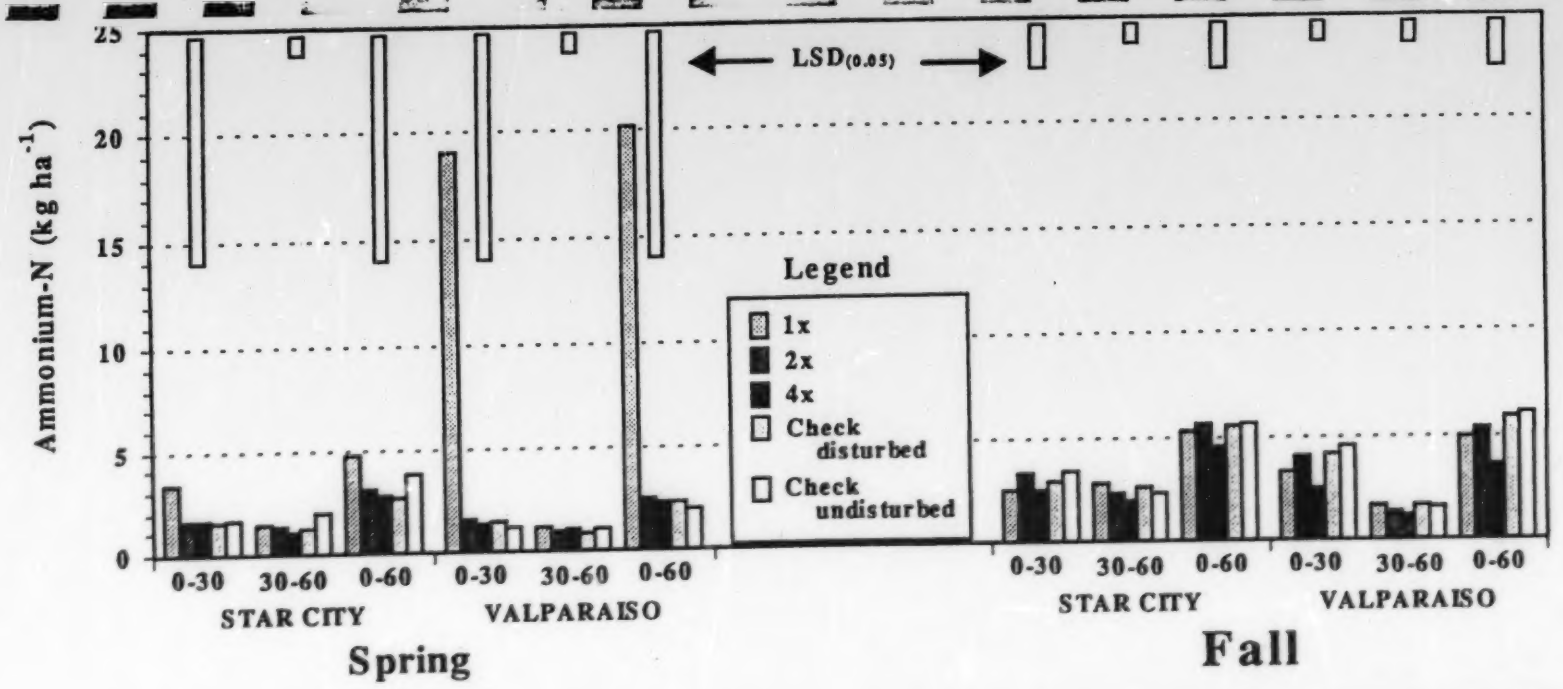
01986

Concentrations in Hog Manure Applied at Star City and Valparaiso in Fall 1999 for 2000 Season

	Tot. N	NH4	NO3	Tot. P	Avail P	K	Ca	Mg	Cu	Fe	Mn	Zn
	ug/ml											
	1821	1520	-	39	1.0	1149	417	121	0.2	26	1.3	1.3
	Application rates of nutrient in kg/ha											
Rate gpa												
3330	67	56	-	1.4	.04	43	15	4.5	0.01	1.0	.05	.05


GMC (%)
25
20
15
10
5
0
LSD(0.05)
Legend
1x
2x
4x
Check disturbed
Check undisturbed
0-30
30-60
0-60
STAR CITY
VALPARAISO
Spring
Fall


NO3-N (kg ha-1)
25
20
15
10
5
0
LSD(0.05)
Legend
1x
2x
4x
Check disturbed
Check undisturbed
0-30
30-60
0-60
STAR CITY
VALPARAISO
Spring
Fall


Ammonium-N (kg ha-1)
LSD(0.05)
Legend
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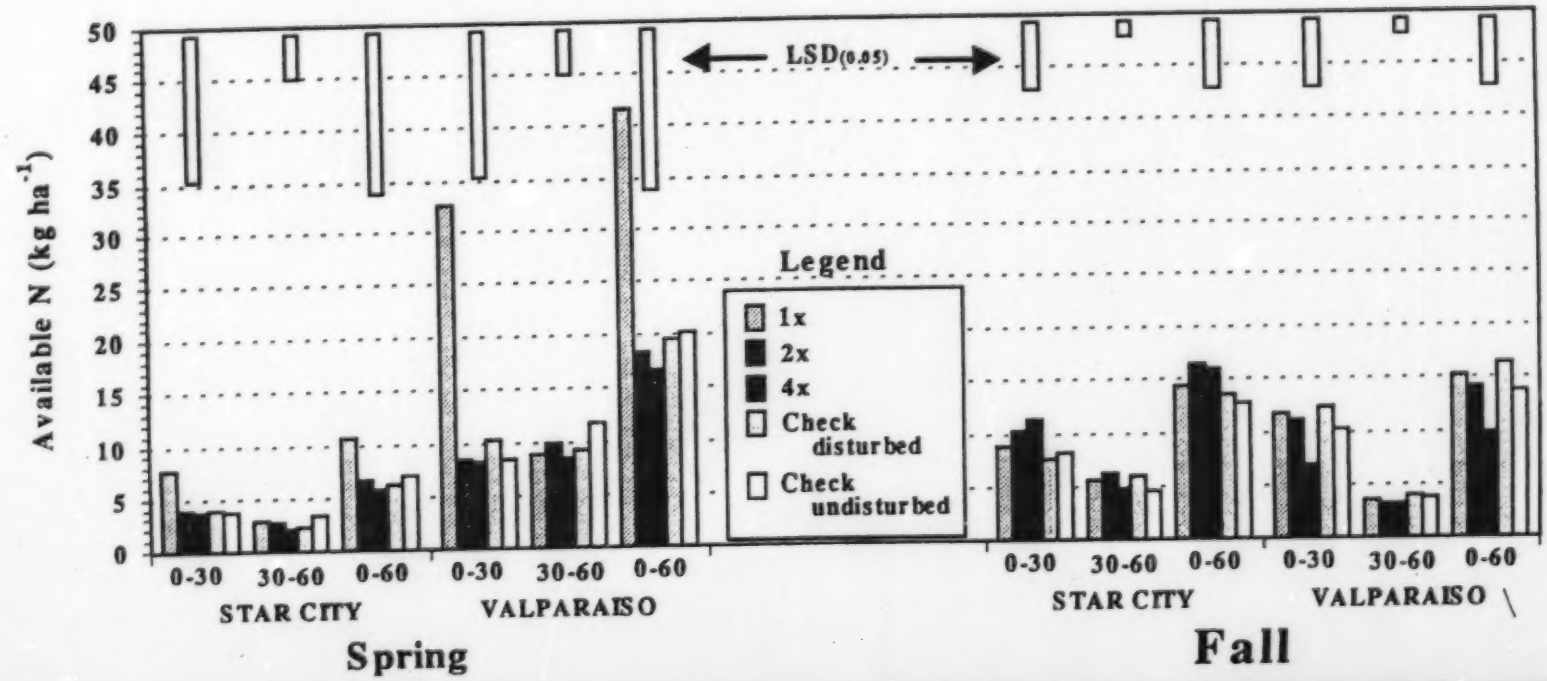
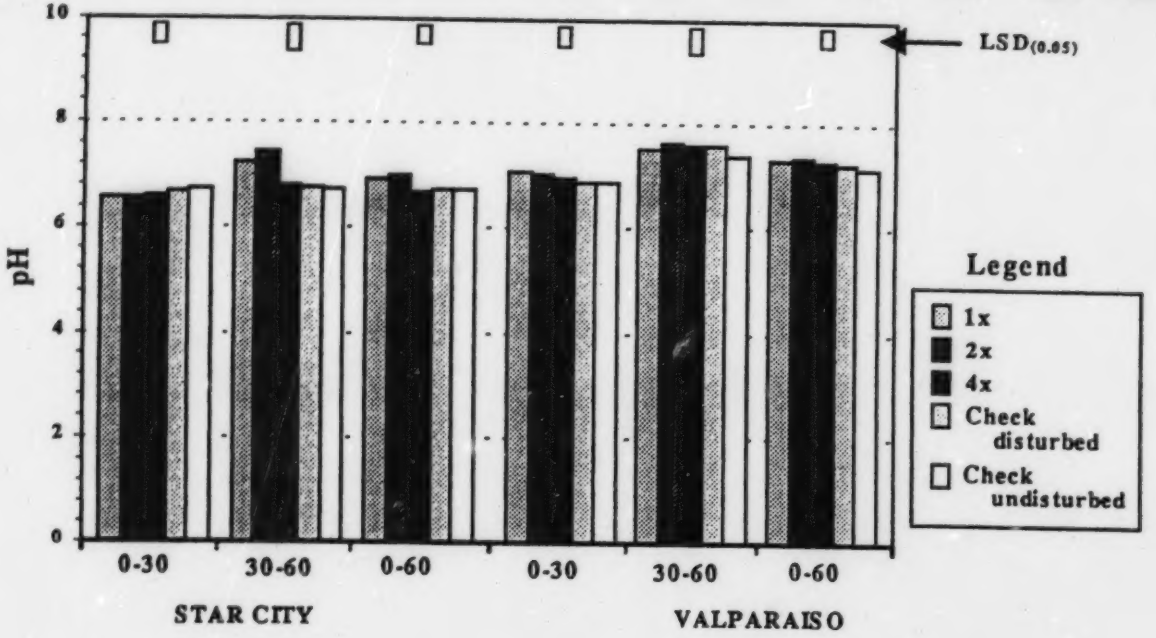
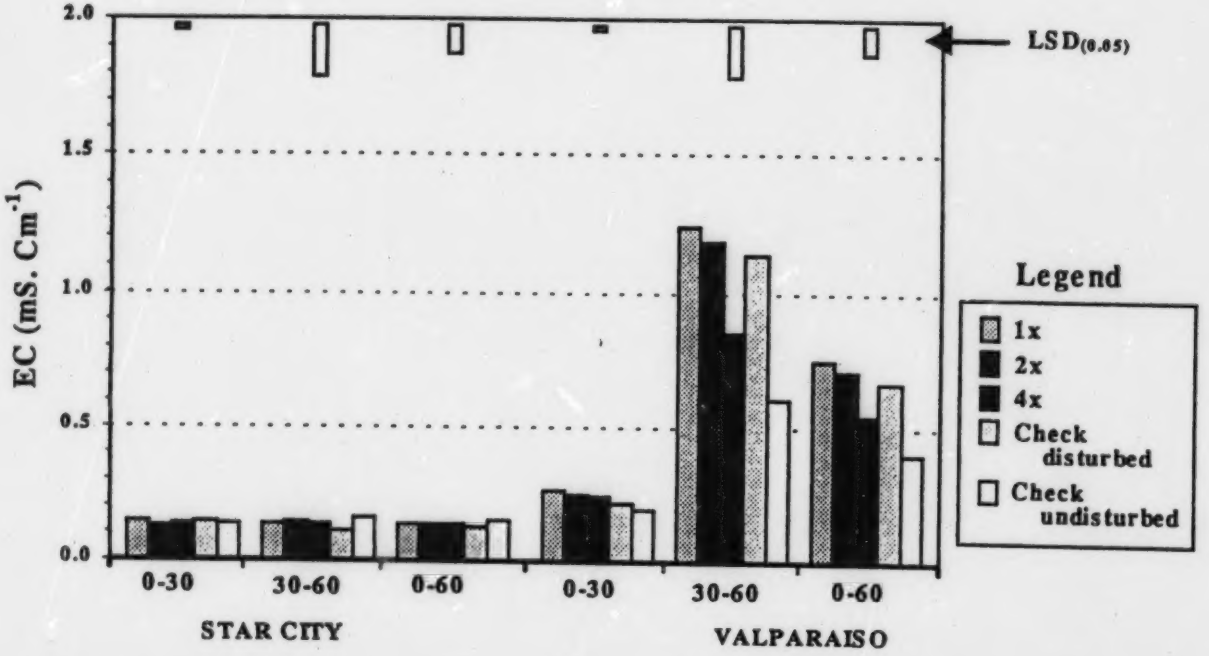
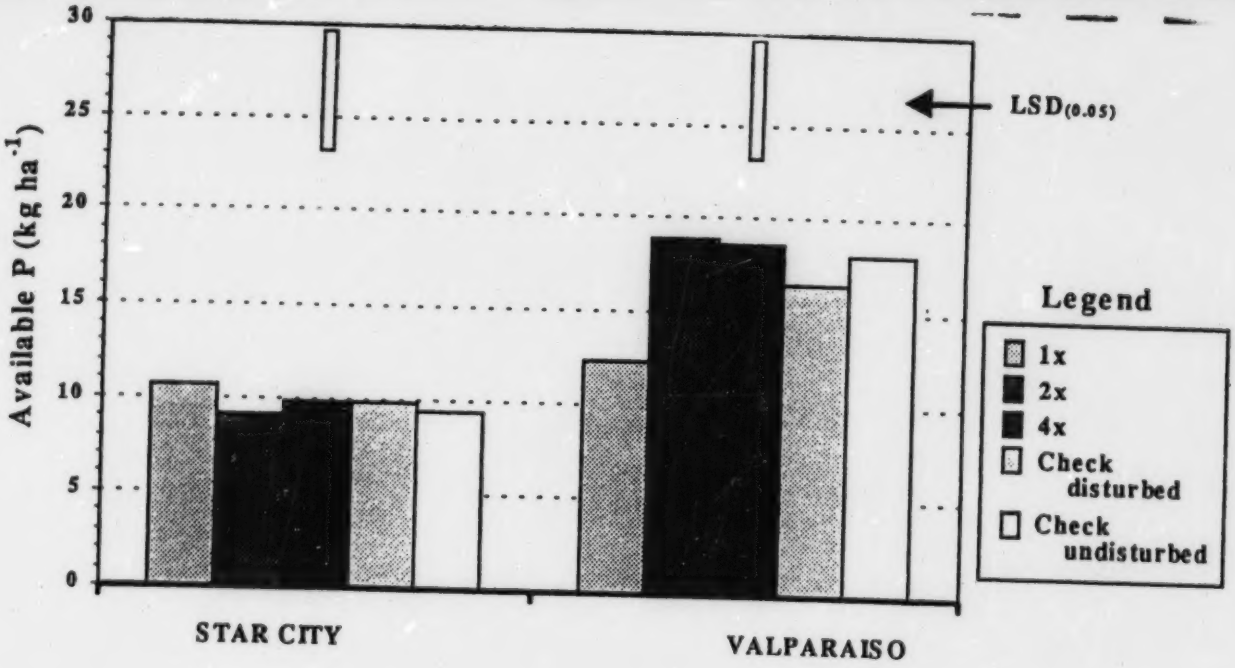
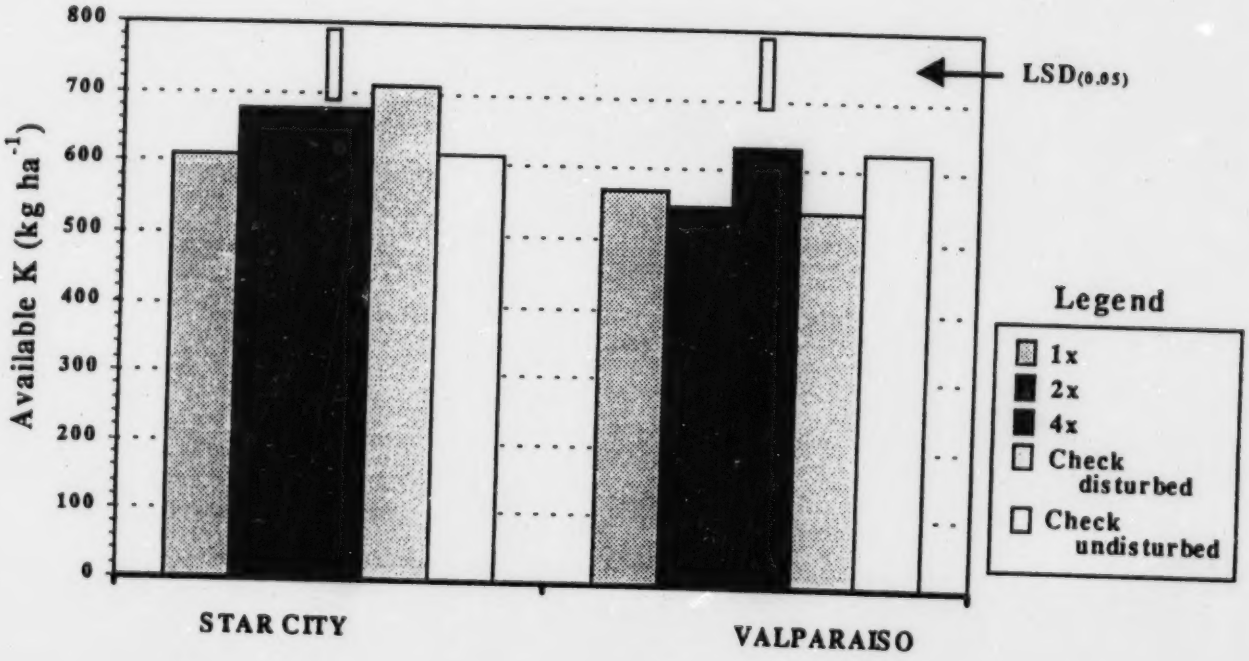
2x
4x
Check disturbed
Check undisturbed
0-30
30-60
0-60
STAR CITY
VALPARAISO
Spring
Fall


Available N (kg ha-1)
LSD(0.05)
Legend
1x
2x
4x
Check disturbed
Check undisturbed
0-30
30-60
0-60
STAR CITY
VALPARAISO
Spring
Fall


10
8
6
4
2
0
pH
LSD(0.05)
Legend
1x
2x
4x
Check disturbed
Check undisturbed
0-30
30-60
0-60
0-30
30-60
0-60
STAR CITY
VALPARAISO


2.0
1.5
1.0
0.5
0.0
EC (mS. Cm-1)
LSD(0.05)
Legend
1x
2x
4x
Check disturbed
Check undisturbed
0-30
30-60
0-60
0-30
30-60
0-60
STAR CITY
VALPARAISO


30
25
20
15
10
5
0
Available P (kg ha-1)
LSD(0.05)
Legend
1x
2x
4x
Check disturbed
Check undisturbed
STAR CITY
VALPARAISO


800
700
600
500
400
300
200
100
0
Available K (kg ha-1)
LSD(0.05)
Legend
1x
2x
4x
Check disturbed
Check undisturbed
STAR CITY
VALPARAISO

CLARENCE MITCHELL (Star City)

		D.M. Yield (MT/ac)			Yield (% of chk undis)			Protein (% of D.M.)			Carotene (mg/lb)		
		1998	1999	Total	1998	1999	Total	1998	1999	Wtd Ave	1998	1999	Wtd Ave
1.	50 LB N	1.13	1.91	3.04	74	155	115	18.2	21.7	20.4	91.5	125	113
2.	100 LB N	1.76	2.22	3.98	114	180	147	18.7	23.2	21.2	100.6	134	119
3.	200 LB N	1.92	2.18	4.10	125	178	151	19.9	23.1	21.6	99.2	128	114
4.	CHK DIS	1.25	1.06	2.31	81	86	84	17.4	21.3	19.2	88.6	125	105
5.	CHK UNDIS	1.54	1.23	2.77	100	100	100	16.8	21.5	18.9	86.4	127	105
	Mean	1.52	1.72	3.24	98.80	140	119	18.2	22.2	20.3	93	128	111

HOG MANURE TREATMENT TEST

CLARENCE MITCHELL (Star City)
1999

	D.M. Yield (kg/ac)			Yield (% of chk undis)			Protein (% of D.M.)			Carotene (mg/lb)		
	Cut 1	Cut 2	Total	Cut 1	Cut 2	Total	Cut 1	Cut 2	Wtd Ave	Cut 1	Cut 2	Wtd Ave
1. 50 LB N	690	1,219	1,908	123	182	155	21.6	21.7	21.7	119	129	125
2. 100 LB N	1,038	1,178	2,216	185	176	180	22.2	24.0	23.2	122	145	134
3. 200 LB N	1,050	1,132	2,182	187	169	178	22.2	24.0	23.1	119	142	131
4. CHK DIS	476	583	1,059	84	87	86	20.5	22.1	21.3	116	132	125
5. CHK UNDIS	560	669	1,229	100	100	100	20.5	22.3	21.5	115	137	127
Mean	763	956	1,719	136	143	90	21.4	22.8	22.2	118	137	129
F value	15.05	0.757	34.225	15.1	0.76	34.225	2.51	8.81	6.3061	0.4	2.23	1.2169
LSD (0.05)	215	586	288	28	61	16	2	1	1	14	14	11
C.V. (%)	18.1	38.3	10.8	18.1	38.3	10.8	5.2	3.2	3.3	7.5	6.6	5.7

TEST NAME HOG-CM YEAR SEEDED

HARVEST DATA: YEAR 1999 CUT Total DATE

TYPE OF DATA: Yield (KG D.M./ac.)

Description	I	II	III	IV	Total	Average	% of Chk undis
1. 50 LB N	2,014	2,091	1,782	1,746	7,633	1,908	155
2. 100 LB N	2,210	2,176	2,113	2,365	8,864	2,216	180
3. 200 LB N	1,851	2,326	2,051	2,500	8,728	2,182	178
4. CHK DIS	1,104	1,223	859	1,048	4,234	1,059	86
5. CHK UNDIS	1,357	1,237	1,171	1,149	4,914	1,229	100
	8,536	9,053	7,976	8,808	34,373	8,593	
AVERAGE	1,707	1,811	1,595	1,762	6,875	1,719	140

	SS	df	MS	F	
Total	5161298.6	19	271647		
Treatment	4696173.8	4	1174043	34.225	s
Rep	53480.229	3	17826.7		
Error	411644.52	12	34303.7		

Coeff.of Var. (%) 10.8

t (.025) = 2.201

LSD (.05) 288

TEST NAME HOG-CM YEAR SEEDED

HARVEST DATA: YEAR 1999 CUT 1 DATE Jun 15/99

TYPE OF DATA: Yield (KG D.M./ac.)

Description	I	II	III	IV	Total	Average	% of Chk undis
1. 50 LB N	897	696	587	579	2,759	690	123
2. 100 LB N	1,112	1,019	900	1,122	4,153	1,038	185
3. 200 LB N	839	1,217	923	1,220	4,199	1,050	187
4. CHK DIS	457	512	384	549	1,902	476	85
5. CHK UNDIS	632	535	515	558	2,240	560	100
	3,937	3,979	3,309	4,028	15,253	3,813	
AVERAGE	787	796	662	806	3,051	763	136

	SS	df	MS	F	
Total	1387351	18	77075		
Treatment	1148873	4	287218	15.0534	s
Rep	28597.7	3	9532.58		
Error	209880	11	19080		

Coeff.of Var. (%) 18.1

t (.025) = 2.201

LSD (.05) 215

TEST NAME HOG-CM YEAR SEEDED

HARVEST DATA: YEAR 1999 CUT 2 DATE July 27/99

TYPE OF DATA: Yield (KG D.M./ac.)

Description	I	II	III	IV	Total	Average	% of Chk undis
1. 50 LB N	1,117	1,395	1,195	1,167	4,874	1,219	182
2. 100 LB N	1,098	1,157	1,213	1,243	4,711	1,178	176
3. 200 LB N	1,012	1,109	1,128	1,280	4,529	1,132	169
4. CHK DIS	647	711	475	499	2,332	583	87
5. CHK UNDIS	725	702	656	591	2,674	669	100
	4,599	5,074	4,667	4,780	19,120	4,780	
AVERAGE	920	1,015	933	956	3,824	956	143

	SS	df	MS	F
Total	1627190	16	101699	
Treatment	406798	4	101699	0.75682 ns
Rep	10997.2	3	3665.72	
Error	1209395	9	134377	

Coeff.of Var. (%) 38.3

t (.025) = 2.262

LSD (.05) 586

DON SQUIRES (Valparaiso)

	D.M. Yield (MT/ac)			Yield (% of chk undis)			Protein (% of D.M.)			Carotene (mg/lb)		
	1998	1999	Total	1998	1999	Total	1998	1999	Wtd. Ave.	1998	1999	Wtd. Ave.
1. 50 LB N	1.34	0.36	1.70	71	55	63	18.9	20.9	19.3	97	112	100
2. 100 LB N	1.48	0.69	2.17	90	106	98	18.3	19.9	18.8	91	113	98
3. 200 LB N	1.73	0.70	2.43	101	108	105	17.4	20.2	18.2	91	111	97
4. CHK DIS	1.36	0.42	1.78	74	65	70	19.0	19.4	19.1	94	108	97
5. CHK UNDIS	1.75	0.65	2.40	100	100	100	18.5	19.7	18.8	95	115	100
Mean		0.56	2.10	87	87	87	18.4	20.0	18.9	94	112	99

1999: 1 cut only

DON SQUIRES (Valparaiso)

1999

	D.M. Yield (tonnes/ac)			Yield (% of chk undis)			Protein (% of D.M.)			Carotene (mg/lb)		
	Cut 1	Cut 2	Total	Cut 1	Cut 2	Total	Cut 1	Cut 2	Wtd Ave	Cut 1	Cut 2	Wtd Ave
1. 50 LB N	0.36	ERR	0.36	55	ERR	56	20.9	ERR	20.8	112	ERR	112
2. 100 LB N	0.69	ERR	0.69	106	ERR	107	19.9	ERR	19.9	113	ERR	113
3. 200 LB N	0.70	ERR	0.70	108	ERR	109	20.2	ERR	20.1	111	ERR	111
4. CHK DIS	0.42	ERR	0.42	65	ERR	66	19.4	ERR	19.4	108	ERR	108
5. CHK UNDIS	0.65	ERR	0.65	100	ERR	100	19.7	ERR	19.7	115	ERR	115
Mean	0.56	ERR	0.56	87	ERR	87	20.0	ERR	20.0	112	ERR	112
F value	6.517	ERR	6.517	6.517	ERR	6.517	2.054	ERR	2.054	0.497	ERR	0.497
LSD (0.05)	197	ERR	197	34	ERR	34	1	ERR	1	11	ERR	11
C.V. (%)	22.2	ERR	22.2	22.2	ERR	22.2	3.9	ERR	3.9	6.2	ERR	6.2

TEST NAME HOG-DS YEAR SEEDED

HARVEST DATA: YEAR 1999 CUT 1 DATE June 15/99

TYPE OF DATA: Yield (KG D.M./ac.)

Description	I	II	III	IV	Total	Average	% of Chk undis
1. 50 LB N	422	435	221	360	1,438	360	56
2. 100 LB N	694	697	632	725	2,748	687	107
3. 200 LB N	861	686	635	621	2,803	701	109
4. CHK DIS	516	519	320	336	1,691	423	66
5. CHK UNDIS	804	796	400	580	2,580	645	100
	3,297	3,133	2,208	2,622	11,260	2,815	
AVERAGE	659	627	442	524	2,252	563	

	SS	df	MS	F
Total	626992	17	36881.9	
Treatment	408630	4	102157	6.51651 s
Rep	61595.5	3	20531.8	
Error	156767	10	15676.7	

Coeff.of Var. (%)	22.2
t (.025) =	2.228
LSD (.05)	197

Appendix II

Agronomic Response to Swine Manure on Dehy Alfalfa Under Zero Till

SWINE MANURE BANDING STUDY - MELFORT 1998

	Crop Stand (plant/m2)	Harvest Biomass (kg/ha)	Straw Yield (kg/ha)	Grain Yield (kg/ha)	Harvest Index	Grain N Yield (kg/ha)	Straw N Yield (kg/ha)	Total N Yield (kg/ha)	Grain N (%)	Straw TKN (%)
1. Manure - 50 lb/ac N	289	6944	4931	2013	0.290	68 bc	20 c	88 bc	3.39 bc	0.42 c
2. Manure - 100 lb/ac N	295	7303	5311	1992	0.273	69 bc	23 bc	92 bc	3.46 b	0.44 bc
4. check disturbed	367	6457	4554	1903	0.293	62 bc	18 c	80 c	3.26 bc	0.41 c
5. check undisturbed	369	6993	5092	1901	0.278	61 c	23 bc	84 bc	3.22 c	0.44 bc
6. Fert N - 40 lb/ac N	352	7190	5131	2059	0.290	70 b	23 bc	93 b	3.39 bc	0.45 bc
7. Fert N - 80 lb/ac N	356	7579	5475	2104	0.280	80 a	29 ab	109 a	3.80 a	0.53 ab
8. Fert N - 120 lb/ac N	343	7539	5410	2129	0.290	82 a	33 a	115 a	3.86 a	0.60 a
3. Manure - 200 lb/ac N *	322	6319	4249	2070	0.330	73	18	91	3.54	0.43
Study Mean	389	7144	5129	2014	0.285	70	24	94	3.48	0.47
Pr>F	0.2865	0.6496	0.7797	0.5092	0.9786	0.0002	0.0288	0.0001	0.0001	0.0197
C.V.	17	13	17	9	13	8	24	8	4	16

* treatment 3 not included in analysis, means shown for comparison only

Swine Manure Banding Study 1998 - Melfort
Fall Soil Nutrient Analysis Summary

Depth	---- Manure, 56 kg/ha ----			---- Manure, 112 kg/ha ----			---- Manure, 224 kg/ha ----			---- Check disturbed ----		
	NH_4-N (kg/ha)	NO_3-N (kg/ha)	Avail P (kg/ha)	NH_4-N (kg/ha)	NO_3-N (kg/ha)	Avail P (kg/ha)	NH_4-N (kg/ha)	NO_3-N (kg/ha)	Avail P (kg/ha)	NH_4-N (kg/ha)	NO_3-N (kg/ha)	Avail P (kg/ha)
0-15 cm	9.1	7.3	26.1	9.4	11.8	29.9	9.7	10.3	35.9	9.0	7.2	35.3
15-30 cm	8.0	1.1		9.5	1.8		8.5	7.2		8.9	1.4	
30-60 cm	15.9	1.6		16.3	3.2		18.4	8.1		16.8	2.0	
60-90 cm	18.4	3.8		16.1	8.1		18.8	10.8		21.3	4.1	
90-120 cm	19.3	6.3		17.5	14.8		31.4	14.3		22.2	7.2	
TOTAL	70.7	20.1	26.1	68.8	39.7	29.9	86.8	50.7	35.9	78.2	21.9	35.3

	---- Check undisturbed ----			---- Fertilizer, 45 kg N/ha ----			---- Fertilizer, 90 kg N/ha ----			---- Fertilizer, 135 kg N/ha ----		
	NH_4-N (kg/ha)	NO_3-N (kg/ha)	Avail P (kg/ha)	NH_4-N (kg/ha)	NO_3-N (kg/ha)	Avail P (kg/ha)	NH_4-N (kg/ha)	NO_3-N (kg/ha)	Avail P (kg/ha)	NH_4-N (kg/ha)	NO_3-N (kg/ha)	Avail P (kg/ha)
0-15 cm	9.0	5.5	32.5	9.8	9.2	33.6	9.2	9.1	26.4	10.1	12.8	20.1
15-30 cm	8.9	1.0		8.4	1.8		9.0	4.8		8.6	13.7	
30-60 cm	17.5	1.6		17.2	2.3		16.8	6.1		16.6	16.0	
60-90 cm	19.3	4.1		17.9	6.8		19.0	18.4		16.8	24.0	
90-120 cm	22.2	6.8		21.3	10.6		20.6	16.9		20.8	22.7	
TOTAL	76.9	19.0	32.5	74.6	30.7	33.6	74.6	55.3	26.4	72.9	89.2	20.1

SWINE MANURE BANDING STUDY - MELFORT 1999

	Crop Stand (plant/m^2)	Head Counts (head/m^2)	Harvest Biomass (kg/ha)	Straw Yield (kg/ha)	Grain Yield (kg/ha)	Harvest Index	Grain N Yield (kg/ha)	Straw N Yield (kg/ha)	Total N Yield (kg/ha)	Kernel Weight (g/1000)	Grain Protein (%)	Straw TKN (%)
1. Manure - 50 lb/ac N	133 d	323 bcd	7225 abc	3786	4023 b	0.477	84 c	13 b	96 c	40.0 abc	12.2 c	0.33 b
2. Manure - 100 lb/ac N	138 cd	281 d	6658 bc	3893	3234 c	0.420	64 d	13 b	76 d	39.0 bcd	11.6 d	0.33 b
4. check disturbed	145 bcd	304 cd	6151 c	3429	3183 c	0.459	65 d	11 b	76 d	38.7 cd	12.0 cd	0.34 b
5. check undisturbed	158 abcd	287 d	6192 c	3445	3214 c	0.453	63 d	11 b	74 d	38.3 d	11.5 d	0.33 b
6. Fert N - 40 lb/ac N	177 a	351 abc	7720 ab	4250	4058 b	0.462	84 c	15 b	99 c	40.2 abc	12.1 c	0.35 b
7. Fert N - 80 lb/ac N	172 ab	401 a	8220 a	4121	4794 a	0.500	116 b	23 a	139 b	40.6 ab	14.2 b	0.55 a
8. Fert N - 120 lb/ac N	162 abc	372 ab	8409 a	4105	5034 a	0.513	130 a	25 a	155 a	40.7 a	15.2 a	0.61 a
3. Manure - 200 lb/ac N *	189	335	6763	3656	3634	0.460	74	11	85	39.3	11.80	0.29
Study Mean	155	331	7225	3861	3934	0.469	87	16	102	39.6	12.7	0.40
Pr>F	0.0323	0.0042	0.0125	0.8497	0.0001	0.6049	0.0001	0.0006	0.0001	0.0334	0.0001	0.0001
C.V.	12	12	13	26	6	15	7	27	6	3	2	15

* treatment 3 not included in analysis, means shown for comparison only

Appendix III

- **PAMI Research Update #751, "Is Swine Manure Injection into Alfalfa Stands a Good Idea?"**

- **PAMI New Release "Injecting Hog Manure into Alfalfa – Soil Test First!"**

PAMI RELEASE

August 7, 2001
Humboldt, SK
Immediate Release

Injecting Hog Manure into Alfalfa - Soil Test First!

The words "recycle and reuse" are an everyday part of all our lives as we become more in tune with our environment. As the agricultural industry enters the twenty-first century, it faces new opportunities as the industry diversifies, and new challenges as it continues to strive for economic and environmental sustainability. With the expansion of the livestock industry, farmers need to develop new ways to utilize manure. Hog manure is an excellent source of fertilizer for cropland, and is a great way to use a waste product and make it into something of value. Injecting hog manure into alfalfa may be advantageous in certain circumstances.

Saskatchewan Agriculture and Food's Agriculture Development Fund provided funding for the three-year research and demonstration project at two sites in the Star City area. PAMI, partnered with the Soil Science Department of the University of Saskatchewan and Kapt-Al Services Ltd., looked into the effects of low disturbance injection of swine manure into alfalfa produced for dehydration (pelleting).

Results from the project were mixed. The Star City site showed an excellent forage yield response to the low disturbance injection of swine manure. The nutrients from the manure more than compensated for the damage to the plant roots caused from the coulter injection system. In contrast, the Valparaiso site resulted in lower forage yields when compared to the untreated check plot. These results show that if the alfalfa stand is deficient in certain nutrients, especially sulphur and phosphorus (and excludes nitrogen), then low disturbance injection of hog manure is beneficial and can increase forage yield in the long term. If there are no nutrient deficiencies, then it is not beneficial and may cause lower yields. Therefore, the first action to take is to have a soil test done to determine the nutrient content.

The project used different rates of application in various sequences to determine the best rate and timing of application. Manure application in the fall appeared to cause less damage, which may be due to the dormant state of the alfalfa at that time of the year. The deeper the injection depth, the better the uptake of the manure, which decreases surface pooling, odour, and nutrient loss. The benefit is that intensive hog operations can now be of value to nearby alfalfa producers.

If you would like more information, call PAMI at 1-800-567-7264, and ask to receive Research Update #751, *Is Swine Manure Injection into Alfalfa Stands a Good Idea?* There is a small charge for shipping and handling. Or, visit our website at www.pami.ca.

-30-

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It is PAMI's policy to acknowledge funding agencies and partners in all News Releases. Your cooperation in ensuring that this happens in any published releases is appreciated.

Printed: June, 2001
Tested at Humboldt, Saskatchewan
ISSN 1188-4770, Group 5(k)

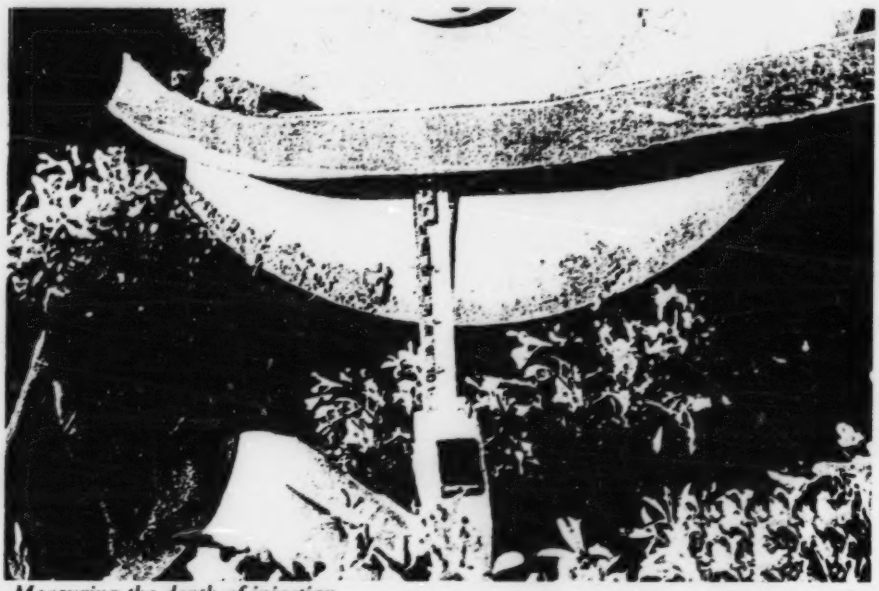
PAMI *Research Update*

www.pami.ca

751

Is Swine Manure Injection into Alfalfa Stands a Good Idea?

The hog industry is growing on the Canadian prairies as demand for pork increases worldwide. The expansion of the hog industry has created a demand for suitable locations for barns where there is land available for hog manure application. Farmers require access to manure management practices that will allow them to add value to their hog production enterprises in an environmentally sustainable way. The application of hog manure is not only a logistical problem that must be addressed, but also an opportunity for producers to utilize a valuable fertilizer resource.



Measuring the depth of injection.

Saskatchewan Agriculture and Food - Agriculture Development Fund provided funding for PAMI to investigate the effect of low disturbance swine manure injection on the yield and quality of alfalfa stands. Injection of swine manure into alfalfa produced for dehydration (pelleting) was undertaken as both a research and demonstration initiative. In this project, PAMI partnered with the Soil Science Department - University of Saskatchewan, Kapt-Al Services Ltd., and farmer co-operators Don Squires and Clarence Mitchell.

At a Glance

Shallow injected swine manure can increase the forage yield of alfalfa if the soil is nutrient deficient. Injection of swine manure is particularly effective when phosphorus, potassium, and sulfur are deficient. Yield increases up to 45 per cent occurred on the test plots and forage protein levels also increased. In contrast, yield decreases can occur due to crop damage by injection when soil nutrient levels are adequate. Farmers who have liquid manure to utilize should soil test their alfalfa fields prior to low disturbance swine manure injection to ensure that the manure application will be beneficial.

What We Did: Alfalfa Trials

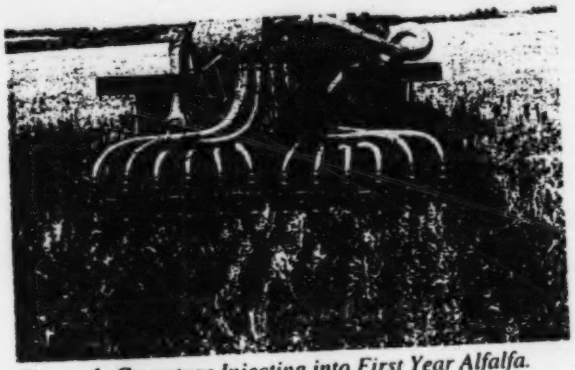


Figure 1. Greentrac Injecting into First Year Alfalfa.

Using a Greentrac manure injection machine (Figure 1), PAMI injected two sites (Star City and Valparaiso) that were in dehy alfalfa production in the Tidsdale, Saskatchewan area. Both sites were seeded to alfalfa in the fall of 1997 on canola stubble. The alfalfa was at the seedling stage when injected in May of 1998 (year 1), and was injected again in May, 1999 (year 2). In year 3, the treatments were applied in the fall of 1999 using PAMI's modified low disturbance manure injector.

At each location, the swine manure was injected into 10 ft x 100 ft (3 m x 31 m) plots. Swine manure was injected to specific plots at an application rate of 3,300 imperial gallons/acre (gpa) (37,000 litres per hectare (L/ha)) all three years; other plots were injected at a rate of 6,700 gpa (75,000 L/ha) in year 1 and 3; and a third set of plots was injected at a rate of 13,300 gpa (150,000 L/ha) which was applied only in year 1.

Two checks were included in the plots; an unworked check, and a check plot where the Greentrac or PAMI injector was operated with the coulters at standard operating depth, but with no swine manure application.

Soil samples were taken before and after injection at 0 - 12 in (0 - 30 cm) depth and analyzed for nitrogen (N), potassium (P), phosphorus (K), and sulphur (S).

A small plot harvester was used to take harvest samples on two separate cutting dates. Kapt-Al Services Ltd. analyzed the harvest samples.

PAMI wishes to thank the Agriculture Development Fund of Saskatchewan Agriculture and Food for its support in making this project possible.

The Results

Star City Site - Nutrient Deficient

Table 1. Three Year Total Alfalfa Yields.

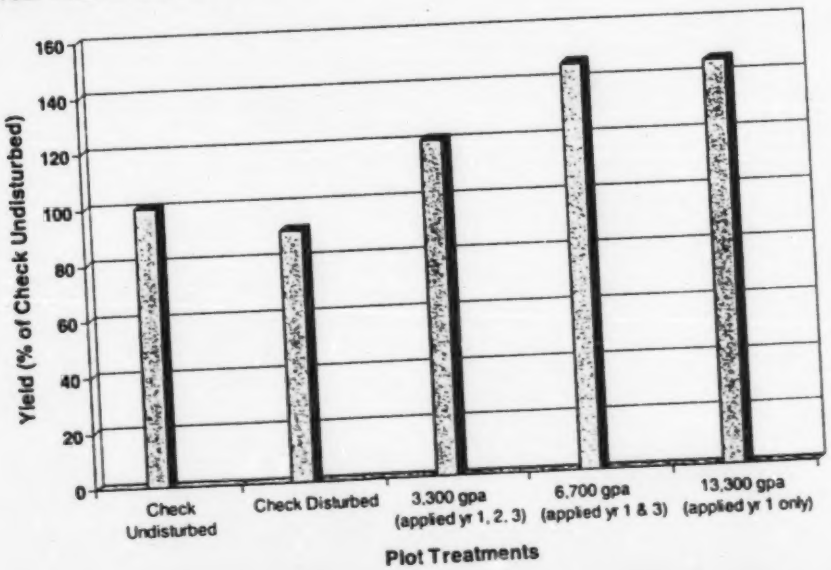
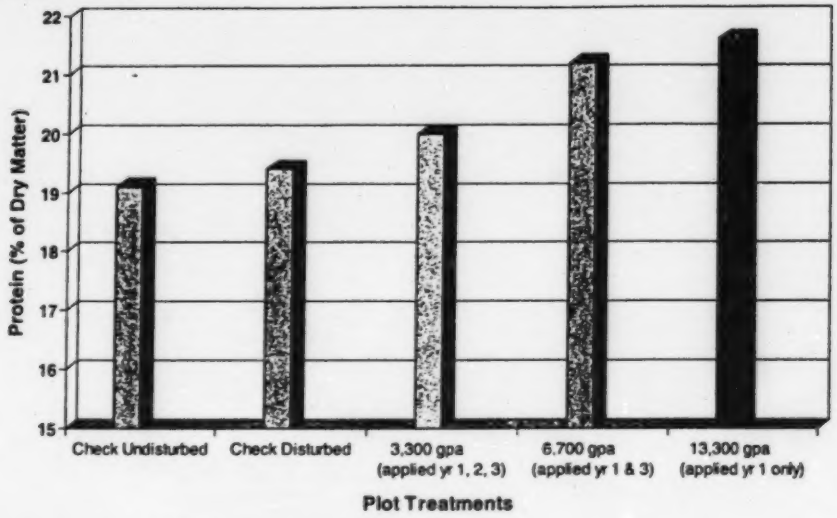


Table 2. Three Year Average Forage Protein.



Valparaiso Site - Not Nutrient Deficient

Table 3. Three Year Total Alfalfa Yields.

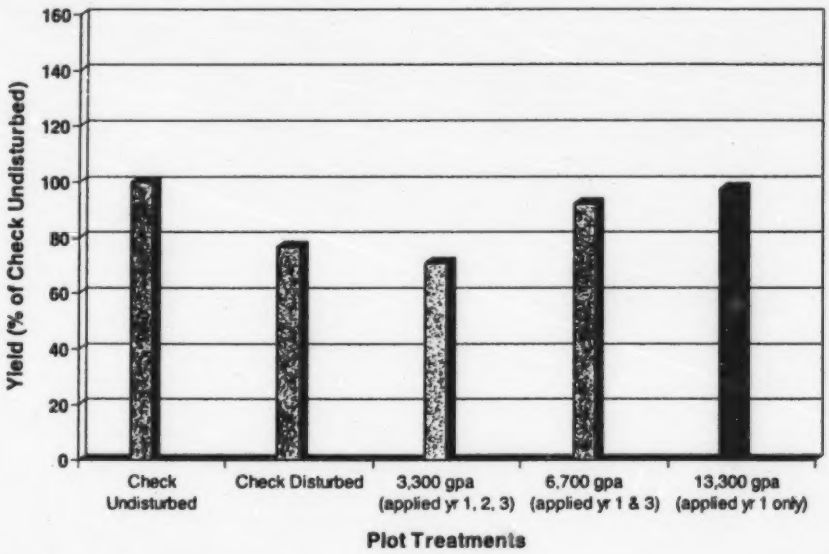
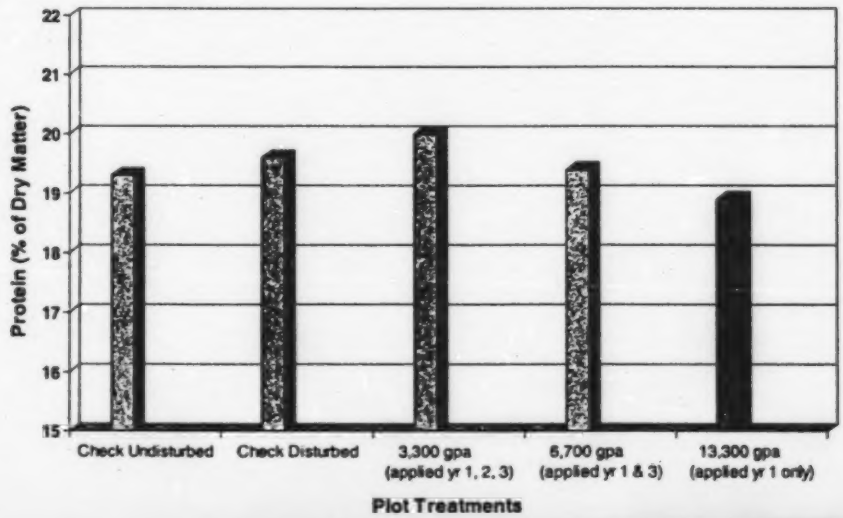


Table 4. Three Year Average Forage Protein.



PAMI's research indicates that the injection of swine manure into established stands of alfalfa will increase yields when there is a nutrient deficiency. The research shows that phosphorus, potassium, and sulfur are growth-limiting factors that could be corrected with swine manure injection. Tables 3 and 4 show that at the Valparaiso site where there was not a significant nutrient deficiency, the yield and protein quality were not improved by the injection of swine manure. Tables 1 and 2 show that at the Star City site where there was a nutrient deficiency that the swine manure injection helped to increase yield and protein quality.

The Greentrac machine was used in year 1 and year 2. In year 3, the Greentrac was replaced with the PAMI low disturbance injector system. The PAMI system has excellent coulter depth penetration, and was available because it was being tested in the area. The new coulter-type injector developed by PAMI, as part of an Agricultural Development Fund project, had modified Bourgault mid-row banders that were capable of 5-inch (13 cm) injection depths (Figure 2). The equipment modifications included stronger springs, and adding weight to the injection toolbar. The deeper injection furrows resulted in improved injection performance with no slurry visible in the furrows at the 3,300 gpa (37,000 L/ha) rate. At the 6,700 gpa (75,000 L/ha)rate, injection performance was lower with slurry showing on 5% of the surface outside the furrow.

It should be noted that the Greentrac coulter injector was not designed for dry, prairie conditions, and its performance limitations under the dryland forage conditions should not be considered a criticism of the product. The Greentrac is a manure injection machine built in Ireland and widely used in Europe for grassland injection. In other projects, the Greentrac is being used successfully to inject swine manure into pasture and forage land.

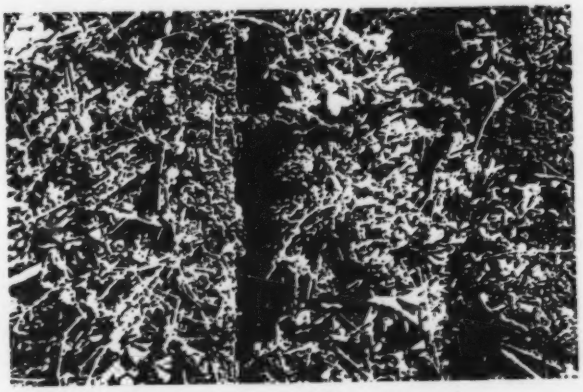


Figure 2. Injection Slot in First Year Alfalfa.

Recommendations

Depth penetration of the manure injection system is important because there is a direct correlation between the depth of the injection slot and the injection performance. The deeper the injection depth (i.e. 5 inches versus 2 inches (13 cm versus 5 cm)) the better the injection performance. This is due to the fact that the deeper injection slot gives more furrow area to take up the liquid manure. This decreases surface pooling and thus odor and nutrient loss.

There appears to be less damage caused to the alfalfa stand when low disturbance swine manure application is undertaken in the fall. This may be attributed to the dormant condition of the plants at this time of year.

Since low disturbance manure injection systems do result in root damage to alfalfa stands, farmers should weigh the benefits of application against the costs involved before proceeding. The injection process does reduce forage yields over the short-term, but the alfalfa plants recover from the mechanical damage and respond with increased yields (38%) when nutrient deficiencies are present prior to injection. Farmers should also soil test to check if there is a nutrient deficiency in phosphorus, potassium, or sulphur. Note that a deficiency in nitrogen is not a factor for healthy alfalfa stands. If the alfalfa has adequate nutrients for growth, the injection of liquid swine manure may not result in a yield or quality increase and may in fact result in a yield decrease. However, injection of swine manure into established forage stands can provide a benefit if there is an existing nutrient deficiency.

The detailed engineering report 0198G, *Low Disturbance Injection of Swine Manure into Alfalfa Produced for Dehy*, is available. There is a shipping and handling charge to obtain this report. You can call 1-800-567-7264 for more details.

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